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Structural controls of lode-gold mineralization by mafic dykes in late-Paleozoic granitoids of the Kochkar district, southern Urals, Russia

Received: 15 October 1998 / Accepted: 18 August 1999

Abstract The Kochkar gold district in the East Uralian Zone of the southern Urals is located in late-Paleozoic granite gneisses of the Plast massif. Gold mineralization is associated with tabular quartz lodes that are preferentially developed along the margins of easterly trending mafic dykes. Fabric development indicates that dykes had a profound influence on the development of shear zones in granitoids. ENE- and SE-trending dykes have been reactivated as dextral and sinistral oblique strike-slip shear zones, respectively, forming a set of approximately conjugate shear zones related to the Permian, regional-scale E-W directed shortening. Dyke-shear zone relationships in the Plast massif are the result of strain refraction due to the presence of biotite-rich, incompetent dykes in more competent granite-gneisses. Deformation and the formation of associated gold-quartz lodes occurred close to peak-metamorphic, upper-greenschist to lower-amphibolite facies conditions. Strain refraction has resulted in partitioning of the bulk strain into a component of non-coaxial mainly ductile shear in mafic dykes, and a component of layer-normal pure shear in surrounding granitoids where deformation was brittle-ductile. Brittle fracturing in granitoids has resulted in the formation of fracture permeabilities adjacent to sheared dykes, that together with the layer-normal dilational component, promoted the access of

mineralizing fluids. Both ore-controlling dykes and gold-quartz lodes were subsequently overprinted by lower greenschist-facies, mainly brittle fault zones and associated hydrothermal alteration that post-date gold mineralization.

Introduction

In the southern Urals of central Russia, large and very large (>100 and >500 t Au) lode-gold deposits are hosted by or closely related to voluminous granitoid massifs, smaller intrusive stocks or granitic dykes (Smirnov 1976; Koroteev et al. 1997; Lehmann et al. 1999). One of the largest of these ore fields with a production of >300 t Au in its over 250 years of mining history is the Kochkar district, located some 80 km to the SW of the city of Chelyabinsk (Fig. 1). Gold mineralization is confined to granitoids and gneisses of the lower-Carboniferous Plast massif which forms part of a number of late-Paleozoic granite-gneiss complexes of the East Uralian Zone in the Urals (Bea et al. 1997; Fershatter et al. 1997). Economic-grade gold mineralization is contained in quartz lodes that are spatially associated with easterly trending mafic dykes, locally termed 'Tabashki'. These dykes describe a crudely radial outcrop pattern along the western margin of the Plast massif (Borodaevsky 1952, 1971; Smirnov 1976). The genetic relationship between petrographically and texturally complex Tabashki dykes and gold-quartz veins has been a point of controversy amongst Russian workers. The main conjecture hinges on the question of whether gold was introduced with the emplacement of mafic dykes, possibly derived from a mantle source (Sazonov et al. 1989), whether the spatial association between dykes and auriferous quartz lodes is merely fortuitous, or whether mafic dykes have represented structural anisotropies along which gold mineralization was developed (Borodaevsky 1971). Up to now, no generally accepted model for the formation of gold-quartz lodes in the Kochkar district has been presented.

Editorial handling: F.M. Meyer

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